

Concept of a Work Management System in Nokia: Focusing on Goals Instead of Process Phases

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Abstract

Complex systems development requires different ways of working than largely used static process oriented work. In practice, workers invent new ways of working to deal with appearing challenges. Thus, a company's processes and tools should support these new process paths. Instead of defining a specific flow to conduct the work, several options for work processes should be allowed. This paper introduced the main findings of a case study conducted in a complex product development environment. The goal of the case study was to improve the company's process support, based on the results of semi-structured interviews and the viewpoints of cognitive approach. The paper points out that it is important to focus on the goals for the work than the actual process phases and task descriptions. As a result of the study, the concept of a Work Management System (WMS) is proposed. The paper introduces this concept and discusses in details the main benefits of using a WMS.

Keywords: Product process development, Work management system, Global product development, Cognitive approach.

1. Introduction

Process-oriented approach for work management in organisations is not a new principle even if interesting to define and describe processes in organisations has been largely adopted in recent decades. In fact, focusing on processes to achieve quality and satisfy customers was promoted by Shewart in the 1930s [1, 2]. Furthermore, the globally adopted and well known quality management standard, the ISO 9001 Quality Management System [3], requires an organisation to apply a process approach to three types of actions: management, product and/or service realisation, and support. In addition, process owners shall be nominated with defined responsibilities and the

authority to implement, maintain, and improve processes continuously. However, it has been pointed out [4] that organisations implementing some of the modern management concepts sometimes fail or do not achieve the expected results. In addition, frequent organisational changes are harmful, as they cause constant extra, and typically not resourced, updating and maintaining of the process management systems [5]. The same kinds of challenges and problems were encountered in our case study, where 40 semi-structured interviews were conducted at the case company premises in Finland. The main findings of the case study are introduced in this paper.

Based on [6] a process can be defined as follows: 'A process is a network of activities that are repeated in time, whose objective is to create value to external or internal customers.' For example, the ISO 9001 standard can be seen to be based on this explication. Traditionally, organisations' product development processes are described and modelled by using process charts, where processes are introduced with models of static swimming courses. However, product development of complex systems differs from the currently used static process-oriented work. In practice, when developing complex systems workers invent new ways of working to deal with challenges that were not earlier defined (i.e., new process paths). Thus, it is difficult to specify a stable set of tasks or procedures for dynamic or unanticipated situations. Changes and unexpected events require creativity and human problem-solving skills in order to be overcome and solved [7]. In this paper, we emphasise the cognitive approaches to be taken into consideration while improving processes and developing process-oriented systems in organisations.

Cognitive work analysis (CWA) is an approach to work analysis focusing on how work can be done [8]. Instead of defining a specific flow to conduct the work, CWA emphasises that there are several options for work in terms of what to do, when to do it, and how to do it. While normative approaches focus on how work should be done, and descriptive approaches focus on how work is done, CWA focuses on the constraints that shape the work [8].

This paper introduces an industrial case study carried out at Nokia (URL: <http://networks.nokia.com/>), as well as a concept for a proposed solution — the work management system (WMS) — based on the case study. Nokia is a large global organization implementing both physical telecommunication network products and software for these products. The main products of Nokia are radio network elements. The case study focused on the development process used at Nokia, affecting the work of approximately 16,000 employees, though an estimated 2,000 people use the process actively in order to obtain instructions for their work. In this kind of environment, while improving a process, it is paramount to start with studies of actual work done. Thus, the ultimate goal of the Nokia case was to improve the working practices and process support by utilising the approaches of cognitive work analysis (CWA). This paper points out that it is important to focus on work goals instead of the actual process phases. In addition, the concept of a work management system is introduced and the main benefits of using a WMS are discussed in more detail. Even if the concept is still under pilot testing and being further developed, we argue that by focusing on the goals and decision points of the work the identified challenges can be managed.

This paper is structured in the following way. In the second chapter, background information relating to the case study, as well as relevant literature concerning the approaches of process management and modelling, business process systems, and cognitive methods are introduced. The third chapter presents the research design of our case study, in a descriptive way, with discussion of the main findings achieved. In the fourth chapter, the proposed solution, the concept of a work management system, is introduced and discussed. Finally, in the fifth chapter the main findings are summarized and concluded.

2. Background

The importance of adopting a process view and continuously improving processes has helped the process management philosophy to become a popular topic in the management literature in recent decades [4]. Based on the

ISO 9001 standard, a process can be seen as a set of activities that are interrelated or that interact with one another. In practice, processes are interconnected, because the output from one process is often the input for another process, and resources are needed to transform inputs into outputs. The ISO process approach points out that a desired result is achieved more efficiently when activities and related resources are managed as a process. Process management is defined as the group of activities involved with organizing and monitoring the execution of a business process [9]. The term usually alludes to the management of business processes and manufacturing processes; even if business process management (BPM) and business process reengineering are interrelated but not identical [9]. Business process management is the discipline that combines knowledge from information technology and knowledge from management sciences and applies this to operational business processes [10]. Van der Aalst [10] identified four key BPM-related activities as follows: 1) model (creating a process model to be used for analysis or enactment); 2) enact (using a process model to control and support concrete cases); 3) analyse (analysing a process using a process model and/or event logs); and 4) manage (all other activities, e.g., adjusting the process, reallocating resources, or managing large collections of related process models).

In BPM the concept of a process model is fundamental [10]. Process models may be used to configure information systems, but they may also be used to analyse, understand, and improve the processes they describe. A process model aims to capture the different ways in which a case (i.e., process instance) can be handled. Process models assist in managing complexity by providing insight and by documenting procedures. Cross-organizational processes can only function properly if there is common agreement on the required interactions. The process-centric view in information systems has no consensus on notations and core capabilities. Despite the availability of established formal languages (e.g., Petri nets), industry has been pushing ad hoc or domain-specific languages. Furthermore, the control-flow perspective (modelling the ordering of activities) is often the backbone of a process model. Other perspectives, such as the resource perspective (modelling roles, organizational units, authorizations, etc.), the data perspective (modelling decisions, data, creation, forms, etc.), the time perspective (modelling durations, deadlines, etc.), and the function perspective (describing activities and related applications) are also essential for comprehensive process models. [10]

In the early Nineties Bernstein and Dayal [11] defined a repository as a *'shared database of information about engineered artefacts produced or used by an enterprise.'*

They described a repository manager as a database application that supports checkout/checkin, version and configuration management, notification, context management, and workflow control. Furthermore, Yan et al. [12] defined business process model repository software as software that supports the management of large collections of business process models. They also stated that software can assist in collections management by supporting common management functions such as storage, search, and version management of models. Thus, the software can also provide advanced functions that are specific for managing collections of process models such as managing the consistency of public and private processes. Accordingly, Dijkman et al. [13] pointed out that repository technology provides the actual infrastructure for storing a collection of process models. In addition, repositories are meant to support many management techniques (e.g., reuse, collection organization, query, search), such that they serve as the central point in an organization, from which the collection of business process models can be managed [13].

In software companies, there are typically several projects that differ greatly from each other, for example, in team size or expertise, product life cycle, or complexity. Therefore, the same process cannot apply to all types of projects. However, defining a new process for each project is not economically feasible. Thus, there is a need to define a series of processes as a process family, or to define a general process, including potential variation points, and then tailor it to each project. In the latter alternative, the tailoring costs are distributed among the projects [14]. Model-driven engineering (MDE) provides a formal framework for defining the models and transformations required for automated process tailoring. However, it requires formalization with various types of models specified and evolved, and it also requires support tools to be successful [15, 16]. The adoption of MDE approaches has been slow due to tool immaturity, as well as organisational and cultural issues [17].

Cognitive work analysis (CWA) is gaining ground in analysis, modelling, design, and evaluation of complex sociotechnical systems [8, 18]. Even though it is mostly used for interface design [8], it is a potential approach for identification of the properties of the work environment and of the workers. As Rasmussen et al. [19] stated, it is *'a methodological tool for planning field studies and data collection in various, actual work domains. It also serves as a means for a consistent analysis of collected empirical data and for representation of the results gained from empirical work studies.'* CWA assumes that in order to be able to design systems that work harmoniously with humans, one has to understand what the work actors do,

their information behavior, the context in which they work, and the reasons for their actions [20]. During the case study, CWA was utilised for providing deeper understanding of the challenges identified in the current work context. In addition, the results were further analysed in order to elicit the main viewpoints and processing requirements for a renewal solution.

3. Research design

In this section, the case study and the research design is introduced. The starting point was that there is a need to renew the product development process in the case company. In practice, the development process in use contains various levels and phases, each focusing on different aspects of product development. The process involves all the stages of product development from ramp-up to ramp-down. In addition to this generic process, there are several process variants which have emerged due the individual requirements of the product programs that use the process. The process itself is large, containing 500 to 1,500 different process documents, depending on the program. For these reasons, tailoring of the process has experienced difficulties. However, the organizational culture in the case company provides much freedom for their employees to tailor the process to serve their needs in the best possible way.

In order to identify the unstructured problems, such as elements that work well in the current process and those that are experiencing challenges, in Autumn 2014 a total of 40 semi-structured interviews [21] were conducted involving various stakeholders from the case company. The semi-structured interview provides information in a more contextual and extensive way than the structured interview, and thus, it is a very useful interview technique in many software process development studies [22]. The interviewed stakeholders represent a wide range of roles (among others, project manager, program manager, product manager, product release manager, designer, tester, and architect) involved in product development in the case company. These interviews aimed towards identifying the requirements for the improved version of the development process and the portal (i.e., the repository) in which process-related information is stored. The interview data was analysed following the principles of thematic analysis, which is a method for identifying, analysing, and reporting themes (patterns) from data [23, 24]. In addition, interview findings were further analysed utilising the cognitive work analysis (CWA) method for understanding the root causes behind the main themes.

In this section, the research process and the main findings are introduced in detail. These findings formed a base for developing a concept of a work management system (WMS) in the case environment.

3.1 The main findings based on interviews

The data collected from the interviews revealed several themes that were formed utilising the thematic analysis method. The findings were divided into two different points of view. The first introduces findings from the process viewpoint: what were the most challenging topics experienced by respondents related to the following of current development processes (introduced in Section 3.1.1). The second introduces findings from the portal viewpoint: what kinds of challenges were identified by respondents relating to the current portal solution (introduced in Section 3.1.2). The interview findings are discussed in Section 3.1.3 and an overview of why cognitive work analysis was needed is provided.

3.1.1 Challenges in the current process descriptions

The top five themes related to the challenges experienced with the current product development process were as follows: 1) ambiguity; 2) heavy; 3) disconnection with stakeholders; 4) roles and responsibilities; and 5) unnecessary work. In this section, these topics are further discussed with examples extracted from the interviews in a manner that retains complete anonymity.

Ambiguity was seen as the most important theme with 19 individual respondents considering the current, generic version of the product development process. In practice, ambiguity was largely seen to stem from the fact that the current product development process aims towards providing guidance for all employees for conducting their work. Since the case company provides several products for the market, with unique features, differing constraints, and produced using various production methods and principles, it is, therefore, extremely challenging to provide detailed information for conducting tasks in the general version of the development process. This has resulted in product and program specific variants, which are often created by the people involved in the development of these separate products. The variants, however, are based on the general version of the development process.

The following citations from the content of the individual respondents illustrate ambiguity: *'It is unclear what elements of the process belong to general level processes and which to more detailed aspects'*, *'Large parts of the process are too abstract and hence not used'*, *'Terminology can be ambiguous, which can be very*

challenging to inexperienced process users.' In fact, ambiguity referred to process descriptions, terminology, acceptance criteria, etc. that were described in the process documentation either insufficiently or in such a manner that multiple interpretations of the information were possible. For example, there were several variants of a process used in different product lines and that's why terminology varied between projects, e.g., *'One has to rely on program specific variants for obtaining necessary information'*.

Heavy process was the second most important theme with 10 individual findings. A heavy process refers to the laborious nature of following the process. In addition, based on the findings, the process has become increasingly heavy during the years it has been developed in the case company. The following citations illustrate the findings: *'The process descriptions are not a good tool for gaining a deeper understanding of the process. They are too heavy for this purpose, which makes reading them a tiring task'*. *'Over the years the process has become increasingly heavy, since the mitigating actions have been added to the process when flaws have been found'*. However, it should also be noted that some of the findings related to this theme stemmed from individuals' negative attitudes towards all kinds of processes, for example, *'Following process details is laborious and a waste of time'*.

Disconnection between different stakeholders was the third most significant theme identified from the interviews with seven individual findings. The following findings illustrate this theme further: *'There is a disconnection between people who define the processes and those who use it. Hence, the process does not serve the actual needs and contains an exhaustive amount of additional responsibilities, such as meetings, that take up most of the work time'*. *'The link between the process and the work has been lost and those who are responsible for developing the process instructions might have been alienated a bit from the 'real' work.'*

In most situations, the disconnections were targeted between the people who define processes and those who use them. However, as described previously, several developers were willing to provide and use product and program specific variants of the process, while process people were trying to serve all employees with a general version of the development process. Furthermore, disconnection between the stakeholders performing different functions of the organization was also identified: *'HW and SW organizations are not working properly together. There is also disconnection between the testing organization and software architecture organization'*.

Roles and responsibilities related findings were indicated also in seven individual interviews. The following excerpts illustrate this theme further: *'The generic process explains the roles, but does not specify the actual persons to contact.'*, *'Sometimes those labelled as process owners are not the 'real' process owners in a sense that they do not have time to put effort on process related matters.'* This theme refers to the ambiguities related to the responsibilities of different roles involved in the development work. In a large organisation, the links between person and role may diverge or blur, which results in uncertainty, gratuitous waiting, or work interruptions.

Unnecessary work was indicated to be a challenge in six individual interviews. Unnecessary work means work that does not contribute to actual product development, even if it consumes resources. Unnecessary work is generally referred to as waste in the literature discussing lean manufacturing [25] and lean software development [26, 27]. Thus, the unnecessary work not only increases expenses but also indicates the ineffectiveness of the processes. The following interview comments illustrate this theme further: *'Different tools are used at different sites resulting in unnecessary manual work.'*, *'In some cases there is a lot of non-value producing work such as unnecessary documents that need to be prepared for a particular milestone.'* The first citation points out a real waste: unnecessary manual work. The second one can be a waste, but it can also be necessary work — perhaps important output — for other stakeholders. So, this type of process should make it clear, and in this way provide a sense of value for producing those kinds of documents.

3.1.2 Challenges relating to the current process portal solution

In this section, interview findings related to the current portal solution are introduced. In practice, interviewers had trouble differentiating the challenges of the process and the portal, because the current process has been implemented as a part of the portal. That was also the reason why there were fewer identified themes in the portal solution than in the process interviews. Only three main themes are introduced in detail.

The top three themes related to the challenges experienced with the current portal solution are as follows: 1) usability; 2) integrity; and 3) lack of visibility. In this section, these themes are discussed with a few examples extracted from the interviews.

Usability of the current portal solution was the most important theme that emerged from the interviews. This aspect was encountered in 29 interviews and covered

several different sub-themes such as finding problems and search capabilities. In this case, usability refers not only to the aspects related to the use of the portal, but also to the ease of finding the actual portal from the web pages of the case company, or to the ease of finding information from the process portal. These sub-themes with illustrative comments are described as follows: *'Finding the link to the portal can be a challenge'*, *'Checklists and templates are difficult to find and their location had to be asked from colleagues'*. Search capabilities and functionalities were mentioned as challenging: *'For example, the portal should utilize a task-based search system that clearly indicates what process to follow.'*

The second most important theme was **integrity** and related to forming a general view of information found in the current portal. This was indicated in eight individual interviews. This aspect is also related to the ambiguity of the process itself, such as ambiguity of the terminology, as discussed above. The comments below illustrate process portal-related integrity further: *'There should be a compact and clear introduction explaining what is found from the portal.'*, *'One needs to know a lot about the process and where to find necessary information'*, *'It's missing how processes work together'*. Respondents expressed the need for visual representation of the processes or hovering with mouse-over instructions.

Lack of visibility pertains to information documented in the process, and information in the work products of those product programs or projects where people currently were working. This was seen as a challenge in three individual interviews. The following comments illustrate this aspect further: *'The portal should provide access to all individual units' internal process variants. This visibility should be applied also so that everyone that is working with the same aspects should be able to see their processes and ways of working.'*, *'All the processes (e.g., delivery process and customer processes) should be found in the portal.'*

Other comments relating to the current portal solution covered the themes of re-use, simplicity, new ways of showing information, and process variants. The use of the portal as a tool for self-learning and re-use was seen as a challenge in two individual interviews. One respondent described this as follows: *'There should be practical examples on how certain things are documented or done. This could be re-used in future projects'*. Three other themes were identified in three separate interviews. An example of a comment relating to new ways of showing information was: *'Scrap the use of PowerPoint and build web pages that provide the content, for example, a program plan could be a web-based template updating*

online. All work is done online these days. In practice, themes of simplicity and new ways of showing information can be also converted to a usability aspect.

3.1.3 Discussion of interview findings

The previously introduced main findings were very explicit and made the case for renewing the activities of the product development process in the case study environment. However, the specific findings relating to the challenges in the current process (3.1.1) and the challenges in the current portal solution (3.1.2) were greatly congruent, because the current process has been implemented as a part of the portal. In addition, the semi-structured interviews were not focused solely on the technical details such as features, possibilities, or constraints of the current portal solution.

In practice, the thematic analysis of the interviews provided the main themes and viewpoints to certain problems or challenging issues. However, in a large organisation there are several variants of a development process and different tools used across several sites. Thus, while interviewing people in different roles and from various sites, the actual root causes of the theme can be totally divergent. This truth does not reduce the significance of the findings instead it forces us to enlarge research activities and also the perspectives of the interview findings. Examples of these kinds of variety within the theme ‘ambiguity’ are as follows: *‘One has to rely on program specific variants for obtaining necessary information.’*, *‘Why are variants created? Could we just get rid of too many variants...’* Accordingly, comments such as *‘hard to find correct or latest information, guidelines, and templates etc. or hard to identify the exact person to be contacted’* can be shown as themes of process ambiguity, heaviness, unnecessary work, or disconnection between different stakeholders, depending on the role and experience of the respondents. The use of the semi-structured interview method offers the means and possibilities to clarify each of the comments and sentences, but the actual root causes are often not clear for a respondent. For this reason, further investigations are needed.

Alongside the semi-structured interviews, it was recognised as important to be familiar with the general development process; process descriptions, phases, milestones, instructions, and templates etc. that are available from the process portal. This kind of process knowledge enables the researcher to ask accurate questions during the interview sessions. In addition, it was recognised that each respondent is a person working in their own way and feeling situations in their personal way.

In practice, there are several options for conducting the work. Thus, the cognitive approach was taken into consideration while analysing the work activities of the respondents. A work analysis is a process of gathering information about work practices. Cognitive work analysis (CWA) provides a framework for work analysis that is seen as convenient for the analysis, design, and evaluation of complex sociotechnical systems [28, 29].

3.2 The cognitive approach for managing work

Generally, work analysis is seen as a systematic process of gathering information about work, tasks, and the relationships among tasks. On the most basic level, a workflow management system is any system that allows its users to setup, execute, monitor, and optimize different workflows. Nowadays, there are plenty of workflow management systems that serve different purposes, provide various features, and are based on different workflow languages. Accordingly, the literature shows various types of methods, ways, viewpoints, and principles for analysing and depicting work processes. Naikar et al. [8] proposed that a feasible level of task abstraction is used to bring in information that explains why and what for the task results are done and used. Thus, it is important to increase the understanding of the worker, instead of only showing the context-dependent practice. Hyysalo et al. [30] argued that while performing knowledge-intensive tasks and solving challenges creatively, a developer must understand both the current state and the goal state, and have a way to reach the goal. This understanding is the basis of problem solving and task implementation. Product development of complex systems differs from currently used static process-oriented work. Workers also invent new ways of working to deal with challenges not earlier defined [31]. Thus, it is difficult to specify a stable set of tasks or procedures for dynamic or unanticipated situations. For providing practical work support and promoting awareness of the progress, process should focus on information content [30].

The cognitive work analysis (CWA) method has been introduced in more detail as it provides an example framework of the cognitive approach for analysing work practices. CWA focuses on how the work can be done, and thus, it is gaining ground in analysis, modelling, design, and evaluation of complex sociotechnical systems [8]. Even though CWA is mostly used for interface design, it is a potential approach for identification of properties of the work environment and of the workers. In order to be able to design systems that work harmoniously with humans, one has to understand the work the actors do, their information behaviour, the context in which they work, and the reasons for their actions. CWA consists of five distinct phases [29]: 1) work domain analysis (WDA); 2) control

task analysis (ConTa); 3) strategies analysis (SA); 4) social organization and cooperation analysis (SOCA); and 5) worker competencies analysis (WCA).

In the literature, much of the research has focused on WDA, the first phase of CWA [32]. WDA focuses on the purposive and physical environments in which people operate. The purposive environment contains the reasons why the system exists and the physical environment includes the available resources. Together, these environments define the objectives that need to be achieved with the given resources. The aim of the second phase, ConTa, is to support people in dealing with recurring, known situations. ConTa focuses on what to do in the given work domain (purposive and physical environments) and complements WDA, since it identifies the activities that are necessary to achieve the goals with the given resources. The third phase, SA, focuses on identifying the different ways to accomplish the activity, i.e., it focuses on how the activity can be done. The fourth phase, SOCA, focuses on who is able to carry out the work requirements of the system, how it can be shared or distributed, and how it can be coordinated. And the fifth phase, WCA, focuses on the competencies that employees need to deal effectively with the work requirements of the system. In addition, there are several key concepts identified in each main analysis step of the CWA approach introduced previously. [8]

CWA provides a systematic framework for studying work content such as the main, required inputs/outputs, the necessary, critical, essential tasks/activities, the needed knowledge/skills/abilities, why the task results are necessary, and what they are used for, etc. Thus, CWA promotes understanding of the interaction between workers and information in the work context. In our case study, CWA was appropriately adapted during semi-structured interviews by collecting artefacts, eliciting current workflows, activities, tasks, tools used, environments, and asking respondents to represent or perform their work practices, for example. Utilising the cognitive approach for analysing the results of interview sessions increased the

understanding of the worker and the work practices, instead of reporting themes without their context.

3.2.1 A renewed solution for supporting work practices

As previously introduced, a thematic analysis was utilised for eliciting the main themes regarding the challenges faced in the current supporting practices for the development processes in the case study. However, it was also recognised that the challenges might be represented in the same way even if their root causes were divergent. For this reason, the themes were further analysed using the CWA approach for understanding the root causes of each theme. Accordingly, the cognitive approach was taken into consideration, while further processing viewpoints and requirements for the proposed solution of a new work management system. In Table 1, example interpretations of utilising CWA in analysis and the provided viewpoints for the renewal solution are introduced.

The analysis of the interviews pointed out that there is a common, well-known and largely used decision-oriented product development process available from the case company portal. Although, there are several variants of the common process produced to meet the demands of specific product programs. The main purpose of decision-oriented development is to ensure that all promised goals are achieved. This means that there is much knowledge, information, and understanding behind each decision. Thus, the proposed solution should support a goal-oriented decision process by producing visibility for information, process work items, etc. The proposed solution should focus on supporting and advising the developer in their daily work, from feature screening, analysis, specification work, architecture design, software design, and testing work, keeping in mind the idea of a 24/7 work week. Thus, the proposed solution must support iterative and incremental work and has to offer the possibility for multiple users to work on the same task, goal, or other information online at the same time (real-time).

Table 1: Viewpoints for supporting work practices

Theme	Example interpretations of utilizing the CWA approach	Viewpoints for a renewal solution (~requirements)
Ambiguity	Ambiguity refers to terminology, process descriptions, work practices, acceptance criteria, etc. that are described in the process documentation either insufficiently, or in such a manner that multiple interpretations of the information are possible. In most cases, the root cause was derived from various product and program-specific variants. In addition, different programs used various tools and work practices. Thus, it was obvious that common process instructions were not familiar or were experienced as too abstract to use. The current solution covers all instructions; the common process instructions that are relevant for a few tasks, as well as detailed specific instructions utilized in other tasks or by persons on different teams.	The main viewpoint for avoiding ambiguity is to offer a single logical data repository that provides various role-based (or responsibility-based) views in a context-sensitive manner. The proposed solution should ensure that the latest information (not only guidelines and help, but also related technology and standards) is easily available for the right person. The purpose is to connect the tasks of individual developers with the proper guidance. In addition, the challenge refers to communication needs (e.g., chats, etc.) that should be easily available with help (hints, examples) or the provision of a society to facilitate communication. There should be support for easily finding the right person to get more information such as asking for advice or recommendations. The renewal solution should provide a view to one's own tasks in relation to the whole.
Heavy process	Heavy process refers to the laborious nature of following the process instructions and fulfilling the decision criteria. A heavy process also refers to the amount of information such as instructions, links, templates, figures, phases, steps, etc. Typically, the process includes a lot of history data and instructions from the several years during which it has been developed; terminology and site-specific instructions have been increasingly expanded during the years. In addition, this kind of common process is heavy and unfeasible to maintain; this involves contradictions in terms, too. The heavy process is one reason for misunderstandings, because the whole picture is unclear. The process can also be experienced as heavy if one utilizes only a small part of the whole	A heavy process can be avoided by reducing the amount of instructions and providing a feasible set of decision criteria. This can be done by focusing on the most relevant information and supporting the development work without separate instructions; some of the decision criteria can be included the work practices, for example. In addition, the guidance can be task specific without being laborious (e.g., YouTube videos). The proposed solution should provide easy and fast maintenance of the process; updates to instructions /templates have to be inherited to all needed places by utilizing links between the items. Furthermore, the solution should ensure traceability of information and history data should be easily available (e.g., by offering traceability items of each build and a baseline configuration).
Disconnection between different stakeholders Roles and responsibilities	The themes of Disconnection between different stakeholders and Roles and responsibilities refer to: 1) disconnection between people who define the processes and those who use them; 2) ambiguities related to the responsibilities of different roles involved in the work; and 3) disconnection between the work and decision criteria. For example, there were identified approver roles that suffered from being too far from the development work content. These kinds of roles and responsibilities have to be checked and adjusted in the current definitions to avoid extra work and misunderstandings	Avoiding these kinds of challenges can be done by developing the process towards a more lean and lightweight solution with process and criteria owners. Currently, part of the decision criterion is merely the 'Definition of Done' as an acceptance criterion. These kinds of criteria need to be integrated into actual work practices. After implementation of the described updates and lightening of the process, the identified challenges can be avoided by offering a single logical data repository that provides various role-based views in a context-sensitive manner (see Ambiguity).
Unnecessary work	Unnecessary work refers to: 1) difficulty in finding correct or the latest information; and 2) difficulties while different site-specific tools and practices are in use. The first indicates ineffectiveness and in this way increases expenses. The second can cause extra manual work with possibilities for mistakes if information is gathered from a tool and transferred to another tool or a document.	Unnecessary work can be avoided in the renewal solution if it ensures the latest information is easily available for the right person. The solution should support and advise daily work with the idea of a 24/7 work week. One of the main viewpoints for the renewal solution is that it should reduce manual work using automation. The automation can be provided with a single data repository, multiple views, and tools that are defined by models producing data to the work product.

4. The concept of a new work management system

In this section the concept of a proposed work management system (WMS) for the case company's environment is introduced.

The current process portal is used for obtaining necessary information about product development-related aspects of the process. This process portal is an online tool that can be found on the intranet: all process descriptions, procedures, instructions, and templates are available via the process portal. In practice, the process portal affects the work of all employees, either directly or indirectly. Thus, improvement and development actions that will be provided to the system are highly recommended, but are also very crucial. Thus, they have to be carefully planned.

The proposed solution of a WMS focuses on decision and decision-oriented process modelling with the purpose of making the decision visible. For example, the system explains what information is needed to make a decision. Decision points or milestones are regarded as basic building blocks of processes and processes themselves compose networks. Downstream decisions are divided into decision criteria, which are documented in such detail that the worker, in principle, can perform their tasks. Tasks are seen as information production activities to satisfy the decision making needed by the corresponding decision-makers.

As a solution, the model of process networks, processes, milestones and decision criteria extended with process communication and signalling structures, as well as roles, were defined. Based on the model, an application was generated, including the process networks and their components that can be instantiated as used process descriptions in the case company. Further, all the data included in the structures defined in the criteria can also be instantiated as project work products.

The solution includes a simple process model that describes only a process hierarchy and how processes communicate. A process is composed of decision points, which further are composed of decision criteria. The decision criteria include the actual guidance, explaining why and how the tasks shall be carried out. There are additional elements, such as common procedures and sub-processes, which are applied by other processes. Process elements are also communicating with each other by signalling and by data exchange.

As described in Figure 1, the WMS connects actual work and process guidance in a practical and seamless way. The data model of work products is defined based on requirements identified by stakeholders of the work domain. The model does not tell much about the sequence in which related information shall be brought in; the order is mostly defined by the process decision funnel.

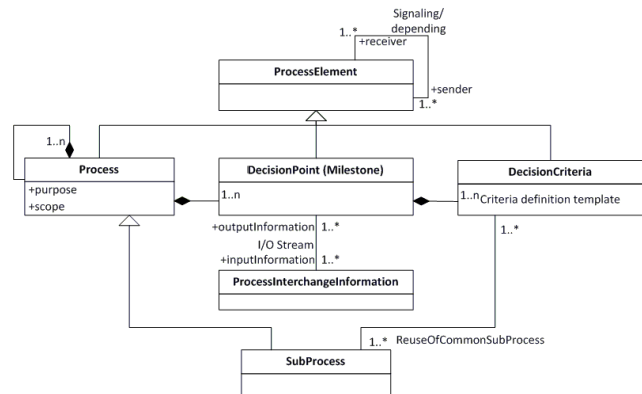


Fig. 1 High level model for a business process.

Furthermore, the order is multi-dimensional and cannot be defined as a clear sequence. The intermediary results are dependent and have effects on each other. This is typically a situation where the developer is the best one to determine the working order, and the order may change case by case. The decision funnel is described by decision points, which are further detailed by decision criteria. Typically, some issues are handled in several successive decision points by more detailed criterion, according to the principles of the funnel. From the work activity viewpoint, this means that from one topic some preliminary information is first collected, then more, and at the end the final set is defined. This explains how the criteria are task descriptions with a goal of produced information. The information is to be used when a decision is made. The produced information can also be used later, and thus, it flows down the process.

The WMS signals and forwards work products according to the decisions of other actors in the development community. The responsibilities of roles are an important part of process decomposition. Signalling synchronizes separate work activities or informs of special kinds of dependencies. Decision points may allow work products to be taken as source information by other parts of the process. The WMS may inform about conflict in work products under development and the developer may follow changes in the work product by expressing interest in following certain information (i.e., changes in the product).

Work management is a system for coordinating and recording the process of passing information, control

signals, and tasks from one worker or machine within a business to another. As technology advances, much work management has become partially automated and takes advantage of special software to make the process smoother. Thus, the WMS improves work performance significantly.

5. Conclusions

This paper introduced a case study that was conducted during 2014–2015 in the Nokia environment. The main goal of the case study was to analyse challenges in the current work context, including process support, in order to provide an improved solution that would effectively support the work practices in the various roles of the company. In addition, the proposed solution, the concept of a work management system (WMS), was introduced and discussed in detail.

The purpose of the WMS is to connect the tasks of individual developers with proper guidance, inform other activities, follow-up, and to gather data for lessons learned. The paper pointed out and discussed several benefits that are enabled with the proposed WMS concept. The proposed WMS supports different ways of performing development work to achieve goals. As stated in the literature [31, 33], decision-oriented, transparent processes can raise a developer's awareness of the people working on a particular decision.

As introduced in the paper, this kind of goal-oriented guidance also promotes innovative work practices. The WMS also supports the main features of decision-oriented development with embedded decision criteria and guidance for a developer and in this way provides visibility to the information needed for making a specific decision. Accordingly, the WMS provides visibility to the progress of tasks and work via various views of traced work products or items. Keeping track of decisions, rationale, and the effects of decisions on software products are also advised in the literature [31, 34]. Traceability and change control functionalities of the WMS enable controlled change decisions with visibility to the rationale behind the changes. In addition, this kind of context-sensitive role of the WMS reduces idle time and unnecessary work; simply expressed, reduces waste in an organisation. Furthermore, a static structure at the highest level of the process hierarchy reduces maintenance cost. The updates and modifications are done once to a particular location of a single logical data repository.

Although in this paper a WMS is introduced mainly as a conceptual framework, a proof of concept (PoC) has been

developed. This PoC has been demonstrated while validating the benefits of the proposed WMS. At the moment, the concept is under further development in the case organisation. The results introduced in this paper should interest academics and practitioners as they indicate how the cognitive approach can be utilised for studying current practices in a large global company. The study also provides valuable insights for academics, as it combines different approaches, such as theories from the information sciences, technology, process and business oriented viewpoints, and cognitive approaches. For practitioners, the introduced case study with the proposed WMS provides a better understanding of the context of the work by defining the real needs of stakeholders, processes, activities, and tasks. In this paper the importance of focusing on work goals, instead of on the actual process phases is introduced and discussed with the concept of a work management system. The benefits of a WMS are also concluded and discussed.

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